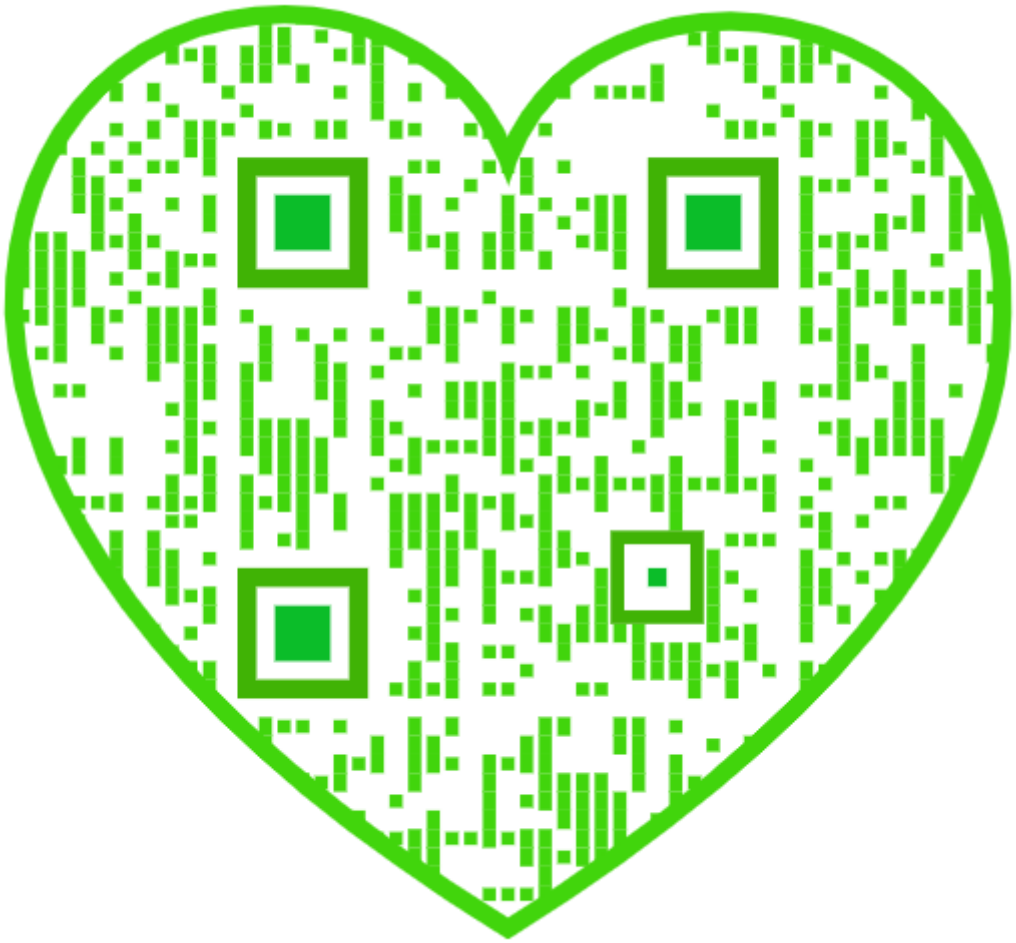

SKETCHING METHODS

By W. C. SWEENEY

Captain, Twenty-first United States Infantry

EDITED AT

THE ARMY WAR COLLEGE

OCTOBER, 1917

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The following pamphlet, "Sketching Methods," Sweeney, is published for the information of all concerned.

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BY ORDER OF THE SECRETARY OF WAR:

TASKER H. BLISS,
General, Chief of Staff.

OFFICIAL:

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The Adjutant General.

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INTRODUCTION.

The writer's idea in publishing "Sketching Methods" is to simplify instruction in the subject and to clear away the mathematics and the mystery which seem to cling to it. The average student becomes confused because almost always he is required to study map making before he gets started on sketching and the result is a jumble of ideas until he learns to work without instruments. When he learns this he has learned to sketch. It is thought that a presentation, in as condensed form as possible, of the methods developed by expert sketchers at the Army Service Schools will be of great assistance not only to students but also to instructors. The writer believes that there is no necessity for teaching the use of the clinometer and scale of slopes in order to teach students how to contour. He believes that sketching can be taught more quickly and as thoroughly by direct methods than by indirect ones. He has tested this belief and proved its soundness. In this time of emergency it is impossible to secure compasses, pacetallys, clinometers, tripods, and other expensive frills that have been a part of sketching for so long. Even if they could be procured there would not be time to teach their use, for intensive training means training under pressure and that means do away with frills and get down to practical and direct methods of instruction.

The student should be taught what scales are, how to make conventional signs and their meaning, how to locate points both horizontally and vertically, how to estimate differences of elevation of critical points, and how to contour by logical methods and finally what is to be shown on a sketch. He should then be given an area to sketch in a limited time for a definite tactical purpose. He should be given several such tasks to do, being always forced to work under pressure, and he will rapidly develop the ability to sketch.

There is no reason why every officer and noncommissioned officer should not learn to sketch and to read sketches within a very short time. The instructor must thoroughly understand

the subject. Common sense must be his guide. His explanations must be clear and simple, for the average man, especially one with a little service, is looking for something hard when you mention sketching to him. A pencil, paper, and home made ruler and board are sufficient tools for the experienced sketcher and should be enough for the beginner.

W. C. SWEENEY.

PRESIDIO, SAN FRANCISCO,
May 26, 1917.

MILITARY SKETCHING.

OBJECT OF SKETCHING.

Military sketching is an art. Its general principles may be learned from textbooks, but the mechanical execution can no more be learned from them than can the art of painting. The degree of proficiency attainable depends upon the intelligence of the sketcher and the amount of time given to its practice.

A map is a projection to scale of the topographic features of the ground. It is made with exact instruments, and its accuracy and completeness are the primary considerations in its making.

A military sketch is a report of the topographic features of a section of country in which certain conventional signs are used as substitutes for words. Its accuracy and completeness are affected by the "time available," the "instruments at hand," and the "tactical conditions" under which the sketcher is working. The difference between a map and a sketch must always be in mind.

A report by means of a sketch contains information which it is practically impossible to convey by written words. Every officer, below field rank, is liable to be called upon at any time to make a report on the country under such conditions that only a sketch will answer. All officers, especially those of field and higher rank, are constantly required to read maps and sketches and to make tactical decisions and dispositions based upon them. The ability to make a sketch guarantees the ability to read and understand both maps and sketches. A sketcher finds no difficulty in reading a map. Ridge and valley lines are at once apparent, and he reads the map easily, rapidly, and understandingly. A sketch is more difficult to read than a map. One who is himself a sketcher has greater facility in reading a sketch, because he can grasp the sketcher's meaning more quickly than can one who has never sketched.

In any well-regulated scheme of instruction for military officers, military sketching occupies an important and distinct place.

The necessity for having junior officers skilled in this art and the advantages accruing from the ability of field and higher ranking officers to read sketches quickly are recognized every-

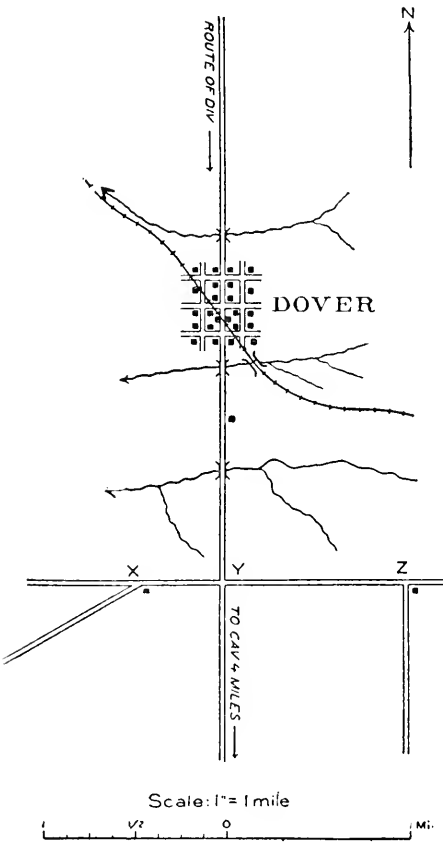


Fig 1

where. In the field, the report by means of a sketch is the rule, not the exception.

An ordinary use of a sketch may be illustrated by the above assumed situation (fig. 1).

Our division is marching south, in hostile country, toward an enemy who was this morning reported to be about 20 miles south of us and moving north. Our cavalry screen is 4 miles south of Y. Our regiment forms the support of the advance guard.

The colonel has a map of the country on a scale of 1 inch to the mile. This map was made several years ago. It shows only the flat detail, houses, towns, roads, railroads, stream lines, trees, etc. The undulations of the country are not shown.

At a halt along the road the colonel calls to you, and, showing you his map, says: "I will arrive at Y at 4.30 p. m. to-day with the point of the advance guard. The division will camp to-night at Dover and the advance guard (less our regiment) about one-half mile south of Dover. Our regiment will form the outpost on a front from X (one-half mile west of Y) through Y to Z (1 mile east of Y). Take four mounted orderlies and reconnoiter from X to Z and far enough to the front for outpost purposes and report to me at Y on my arrival there. I want such a report as will enable me to determine how best to dispose the regiment for outpost duty without unnecessary delay."

On the colonel's map you saw that Y is a crossroad formed by the road over which the division is marching and the straight X-Z road.

You arrive at Y at 1 p m. You have three and one-half hours in which to make the reconnaissance. You must at once recognize that only by means of a sketch can you gather and convey the necessary information to the colonel.

At 4.30 p. m. you hand your sketch to the colonel at Y. Reading it, he quickly gains an idea of the "lay of the land" and is able to dictate his order so that his troops may be marched directly to their several outpost positions.

Sketches vary in the amount and value of the information that they convey in exactly the same manner as do written messages and reports. The same faults are found in all.

It must always be remembered that if there is plenty of time and conditions permit, the commander will send his engineers or others with accurate instruments to make a map of the desired area. As a consequence, sketches are made only when there is not time to make a map or when conditions do not permit it. The time required to make a sketch is always a most important factor. It will usually be found that the sketch is wanted for

use just as soon as it can be gotten, and often that it is wanted in such a short time that only an outline of the desired area can be made. It is in such a case that the judgment, experience, and tactical training of the sketcher play such an important part. If the sketch must be slighted in some parts he must be able to determine what parts to slight and where accuracy and detail are necessary, and he can not determine this unless, knowing the object for which the sketch is made, he realizes what the commander needs to know about the ground.

From the foregoing considerations certain conclusions have been deduced for the guidance of the sketcher. These may be summarized as follows:

(1) The assigned area or distance should be covered in the time allotted.

(2) Clearness is very important. No matter how much valuable information may be gathered, it will be of little use unless it be clearly shown.

(3) The sketch should contain all data of military value to the purposes for which it is needed. It may be a model in its technique and yet have left out some feature of such military value as to make it of little or no use.

(4) A sketch may be inaccurate in many of its measurements and still be so clear in showing what is meant and have such military value that the inaccuracies make no difference. Accuracy, therefore, though always to be sought, must be subordinate in a relative degree to finishing the task in the time allotted, to clearness of expression, and to military value.

The relative importance of the foregoing principles may be determined in each case by a careful summing up of the requirements of the situation which calls for the sketch.

In the assumed situation cited, you should be able to determine at once just what the colonel will want to know about the area before issuing his outpost order. You should, therefore, know what features and distances to estimate and what to measure, where to go fast in your work and where to go slow.

Summing up the situation, you would realize—

(1) That the colonel will need to have a sketch of the whole area before him.

(2) That the information contained in the sketch must be so clear that there can be no mistake about what is meant.

(3) That all features which have value in outpost duty should be especially noted; for instance, a hill about 300 yards south

of Y, commanding the road from the enemy, can be held by comparatively few men. The strength of this position must be indicated on the sketch, as it has a direct bearing on the number of men assigned to the various sectors.

(4) That the sketch must be as accurate as possible, consistent with (1), (2), and (3).

There may arise cases where the judgment of the experienced sketcher will cause him to change the relative value of the foregoing principles. This is to be expected, because each sketch is a problem in which the sketcher must use his best judgment in determining how to gain and to convey the desired information.

The beginner, however, must learn to sketch before he can pay much attention to these considerations. Clearness, accuracy, and speed in the order named should be his guide until he has attained a fair ability in making a sketch.

The habits formed in learning to sketch will have a great influence upon the speed and skill that may be attained. From the start system in the methods of working should be practiced. No one can become expert at sketching unless the habit of working systematically is acquired.

CLASSIFICATION OF SKETCHES.

The name given usually indicates the nature of the sketch. There are two general classes of military sketches: (1) Area sketches; (2) reconnaissance sketches.

Area sketches are classified as:

1. Position sketch. This is a sketch of an area to all parts of which the sketcher has access. Scale usually 6 inches to the mile; V. I., 10 feet.

2. Outpost sketch. In this the sketcher travels along and in rear of the outpost line sketching the area to the front. Scale 6 inches to the mile; V. I., 10 feet.

3. Place sketch. The sketcher is located "in one place" on a hillside or hilltop in a restricted area, from which he sketches the area to the flanks as well as to the front. Scale 6 inches to the mile; V. I., 10 feet.

Reconnaissance sketches are classified as:

1. Road sketch. This is usually made mounted. The sketcher preceding the column sends back his reconnaissance sketches as promptly as possible, so that the commander may use the information contained in them on the march and in making his dispositions. Scale 3 inches to the mile; V. I., 20 feet.

2. River reconnaissance sketch. This is usually made with the idea of securing a special report of topographical features and other features on a river line. Many of these can not be shown by conventional signs and are written on one side of the sketch. These sketches are made mounted. Scale 3 inches to the mile; V. I., 20 feet.

3. Railroad reconnaissance sketch. Similar to the reconnaissance of a river. Scale 3 inches to the mile; V. I., 20 feet.

OUTLINE FOR BEGINNER.

The following is a general outline of the successive steps that may be taken in learning to sketch. It is inserted here merely as a guide to those who are taking up sketching alone or in company with others who are also beginners. The time available to the student must be used to the greatest advantage, and he alone is able to divide it with that in view. For this reason the steps are merely advisory. All indoor practice suggested should be taken up and carried on simultaneously with field work.

In sketching, as in any other art, practice only makes perfect. The steps to be taken by the beginner may be analyzed as follows:

1. Study the conventional signs and practice same (p. 21).

2. Lay off a measured ground course and practice striding and counting strides (double paces) (p. 17).

3. Practice making titles for different classes of sketches (p. 26).

4. Determine stride and construct or select scale of strides for 6 inches to 1 mile and paste on ruler (p. 27).

5. Take out board and practice orienting by turning arrow to north and by backsighting (p. 16).

6. Practice location of points by traversing and intersection (p. 32).

7. Practice estimating horizontal distances in units of 100 yards (p. 33).

8. Practice estimating vertical distances in units of 10 feet (p. 34).

9. Run a traverse for a short distance, putting in horizontal detail only. Practice locating points by traversing, intersection, resection, and estimation (p. 32).

10. Take up study of contours and practice logical or mechanical contouring (p. 38).

11. Keep up practice in making conventional signs by drawing imaginary countrysides (p. 24).

12. Run a traverse again as in figure 9. Practice estimating differences in elevation between critical points and noting same (p. 40).

13. Make two or three such traverses, practicing to acquire speed and *method* in your system of working (p. 43).

Fill in only flat or horizontal detail but be particular to locate the drainage lines. Practice orienting by back sight and checking each time by arrow pointing to north. Put a title on each before considering it finished (p. 46).

14. Select an area $\frac{1}{4}$ to $\frac{1}{2}$ mile square and make a sketch of it. Practice adjustment to close (p. 45). Show all drainage lines clearly.

15. Meanwhile, having practiced logical contouring until you can do it intelligently and rapidly, sketch the same area again in the same manner as before, and in addition estimate and determine elevations of critical points. Now take this sketch and contour it by logical methods (p. 39). Do this at home or at some place from which you can not see the ground you are contouring. The idea of this is to impress upon the beginner the necessity of securing all data that may be needed for contouring upon one traverse over the ground.

16. Make another sketch of the same area. Fill in flat detail as you go and note elevation and location of critical points. When you have the drainage system clearly plotted, contour the sketch on the ground. Space the contours according to the ground (p. 41).

17. Make position sketches of other areas in the same manner as the last one (p. 45). Never start contouring until the drainage system is "pinned down"; the big features will then be seen, and the little ones will take care of themselves.

18. Make at least three outpost sketches and two place sketches at 6 inches to the mile and 10 feet V. I. before attempting to make a road sketch (p. 46).

19. Construct a scale of strides for 3 inches to the mile and take up road sketching dismounted (p. 48).

20. Secure a mount and make a scale reading minutes for trot and walk. Take up mounted road sketching (p. 50).

21. Later take up other kinds of reconnaissance sketching (p. 51).

SKETCHING TOOLS.

Sketching board.—The issue sketching board with a compass set in a trough in one edge is a good board for sketching. It has an attachment on the under side for securing the tripod to it. It is about 13 by 14 inches, which allows 2 miles of position sketch (6 inches to the mile) to be made with enough extra space to secure the paper to the board.

A homemade board of the same size, made of light wood about seven-eighth inch thick, with holes in two diagonally opposite corners for a rope by which to carry it, makes a very good sketching board.

A tripod may be used, but is not necessary. When instructing large classes by intensive methods the compass, pace tally, and tripod should not be used, as it requires too much time to learn their use.

TO ORIENT THE BOARD.

Having tripod and compass.—Set up the tripod with board loosely screwed on to it and level by eye by moving the tripod legs. Note that tripod legs are firmly set so as not to slip easily. Free the needle by turning the cam and then turn the board slowly around until the needle swings from side to side in the trough. Let the needle settle, turning the board so that when settled the needle lies directly over the north line in the bottom of the trough. Without changing the position of the board, reach under and tighten up the screw of the tripod. Care must always be taken not to turn the tripod screw too tight, as the threads are likely to be started by rough treatment. The board is now oriented. Draw a line parallel to the needle on the paper and mark the north end with a half arrow. This magnetic meridian line is sometimes marked M. M.

Without compass and tripod.—Draw a line parallel to the edge of the paper and place a half arrow on one end of it. Turn the board around until the arrow points north and the board is oriented. Use watch and sun or general knowledge to determine north at first; thereafter orient by backsight, but check backsight orientation when necessary by the same methods.

To orient the board by backsight.—Having plotted (located and drawn in) a station and arrived at a point farther on, which you have sighted and drawn a line to, measure off the number of strides taken between the two points on your line

and stick a pin in the point found. This is your present position. Place your ruler against the pin and along the line between the two points, and turn the board until the station which you have just left is sighted. The board is oriented. Verify this by checking arrow or reading the compass needle.

All of these methods of orientation can be practiced in a small space. Set up the board and orient by compass. Stick a pin in your assumed position and draw to a fence post or any object 15, 20, or 100 feet distant. Now move over to near the fence post and set up again. Orient the board by arrow and then verify by a backsight orientation on the first station. For this practice a scale of an inch to a few feet may be assumed and the distances measured. In this case practice may be had from one point to three others and then back to the first. This will give an opportunity to check the accuracy of your orientation by seeing how well your lines close. Intersection and resection methods may also be practiced in this same manner.

Tally register or pace tally.—This instrument is used to keep the record of the number of strides (double paces) taken in measuring the distance between points. It is important that the number of strides be counted as accurately as possible, and for this reason the beginner should learn to register them automatically; that is, without giving the act of pressing the lever any attention.

With the pace tally held in the left hand, finger through ring, the lever is pushed down each time the right foot strikes the ground. This system of recording the strides is the best possible, because the left hand is free to handle the register and after practice will automatically or subconsciously press the lever when the right foot strikes the ground, which occurs when the left hand reaches the forward point of its swing. The more nearly automatic the act of recording the strides becomes, the more can the sketcher's attention be given to observing the configuration of the ground and the details of the country through which he is passing.

However, it is possible to get very good results by training men to count their strides and tally every 100 strides on the edge of the paper. There are various ways of counting and tallying strides without a pace tally. After a little practice each individual will select his own way. The beginner should learn to stride at a uniform gait and to register the strides or to count them with the least mental effort. Do not attempt to take

strides of a certain length, but step along at a natural gait, swinging the arms naturally and keeping the mind off of the counting of strides or of their length. When walking anywhere by yourself practice counting your strides or carry the pace tally and register them. If opportunity offers do this in walking to or from your office or place of business. Practice it as much as possible, and you will soon find that the number of strides in a given distance will become more and more uniform. Until one learns to stride naturally and uniformly the stride will be affected by walking with or near another person.

Once in a while a tally register will be found which occasionally fails to register a change of 100 strides. This can be detected by a peculiar click when it happens. The failure is often due to the sketcher not pressing the lever down far enough. The register can be tested indoors by watching the face of the dial while pressing the lever and tallying through a couple of hundred counts.

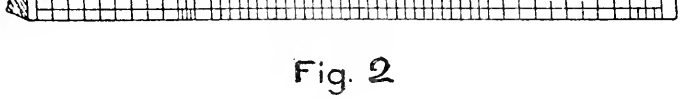


Fig. 2

Triangular ruler (*fig. 2*).—The best ruler for sketching is one of triangular shape about 8 inches long with faces about 0.8 inch wide, with both ends weighted. Such a ruler has been developed at the Army Service Schools and can be bought at slight expense from the Book Department, Army Service Schools, Fort Leavenworth, Kans. It has on it a scale of inches, one of 100 yards at 3 inches to the mile, and one of 100 yards at 6 inches to the mile. There is ample space left on which the sketcher may paste his scale of strides for sketching at 6 inches and at 3 inches to the mile, as well as his horse's walk and trot scale for mounted work. A very satisfactory ruler can be made by sawing in two a piece of pine or other common wood about seven-eighths inch square. This makes a triangular ruler which is convenient in size and shape. It should be cut in 6-inch lengths and should have on it the sketcher's scale of strides, a scale reading 100 yards at 6 and at 3 inches to the mile and an inch scale reading down to a tenth of an inch.

When using the ruler for sighting an object, place one of the edges against the pin in your station, sight along the top edge, and pivot the ruler with forefinger and thumb around the pin until the desired object is in line. Then draw the ray (light line) along the edge of the ruler next to the pin. When sighting up or down a steep slope, the sketcher may find it of assistance to stick a pin vertically in each end of the top edge and use them to sight by.

Pencils.—A soft pencil, HB grade, or Eberhard Faber No. 2 with eraser on it, should be used in learning to sketch. Harder pencils will tear the paper, and their marks are so difficult to see that the sketcher is likely to strain his eyes. When sheet celluloid is used, a 2H pencil is better.

A knife or a pencil sharpener should be carried, and the pencils should always be kept sharp. A piece of emery paper pinned to the carrier is very valuable for putting on a finished point.

Eraser.—A soft rubber eraser is a popular article in the equipment of the beginner. The Ruby, Eberhard Faber, New York, is a very satisfactory one. One on the pencil will serve, however, very nicely.

Paper and thumb tacks.—All sketches should be made on a tracing paper in order that they may be blue printed without the necessity of tracing them. For this reason tracing paper should always be used, except in the earlier practice when any variety of drawing or heavy wrapping paper will do. It will be found that the paper, if pinned to the board by thumb tacks some time before it is to be used, will bulge up and have to be readjusted. For this reason it is well not to pin your paper in position until just before starting out. Extra thumb tacks should be carried. These may be stuck on the under side of the board or kept in a piece of cork in the carrier.

Large-headed pins.—Several of these should be stuck in the carrier or clothing where they can be gotten at conveniently. They are most useful in sketching. Common glass-headed pins about $1\frac{1}{2}$ inches long with a head about one-tenth inch in diameter are best.

Carrier.—This can be made of canvas or heavy cloth sewed over a piece of light wood or heavy cardboard, or they may be purchased at the Book Department, Army Service Schools (fig. 3). The sketcher must have every appliance in its place when he wants to use it, and the carrier offers a most con-

venient place for nearly all of his tools. The carrier, however, is not necessary.

Stop watch and note pad for mounted work (fig. 4).—These are very convenient for mounted work. The pad is divided into blocks. The middle line from the bottom up represents the sketcher's route by minutes and quarter minutes of travel, while the horizontal lines to the sides represent hundreds of yards

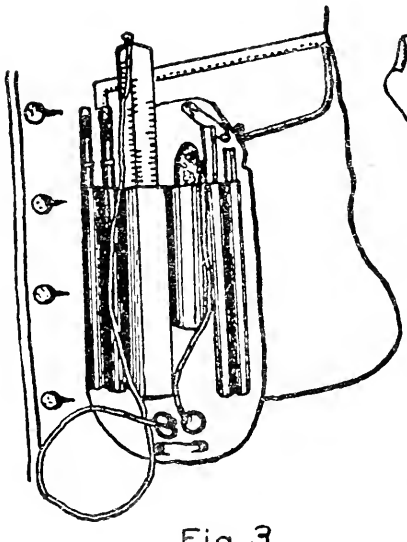


Fig. 3

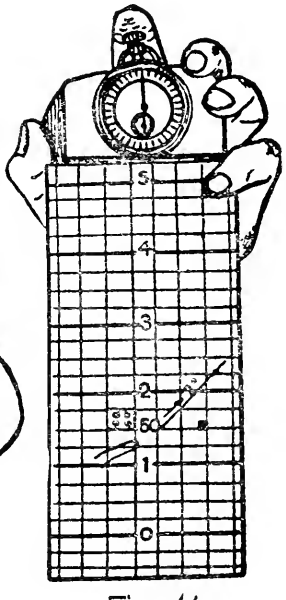


Fig. 4

off from the sketcher's route. As the horse trots along the road, the sketcher jots down on the pad in their proper places the various features which he observes. After some minutes of travel, he dismounts, and, using these notes, sketches in the road over which he has passed. It is well in making notes on the pad to use a blue pencil for noting water courses and horizontal details and a red one for carrying along the elevations. A pencil with red at one end and blue at the other can be purchased at any bookstore.

CONVENTIONAL SIGNS.

The conventional signs used in military sketching are illustrated in Field Service Regulations.

In practical sketching, if it is more difficult or requires more time to make the conventional sign than it does to write what is meant, the experienced sketcher will write the description.

A sketch is made primarily to convey certain information. If what is meant to be conveyed is not clear the sketch is of no use. Again, if it takes a commander too long to read a sketch he will blame the sketcher, and as his time will probably be valuable he may not be able to take time to read it. Always remember that the sketch is being made to be read, that the convenience of the reader is sought, not that of the sketcher, that it is useless to put a mark on the sketch unless that mark has a meaning which the reader will be able to make out.

It is desirable that the conventional signs shall picture what they represent as nearly as possible, so as to be easily interpreted; be simple in construction so that they may be made rapidly; not take too much space on the sketch; and that they be so clear as to be readily understood and not be mistaken one for another.

Practice in rapid work has developed many short cuts in making them. These convey the same information with fewer pencil marks and probably greater clearness (fig. 5).

It is to be noted that the cross marks on a railroad, the signs indicating the different kinds of fences, the marks along a road indicating telegraph line and the T representing a telegraph line across country, are to be made 1 inch to 1½ inches apart on a scale of 3 or 6 inches to the mile. This is done principally for the sake of clearness, though a great deal of time is saved by it. It is, however, an excellent rule never to put a mark on a sketch, no matter how small, that is not necessary.

A culvert or bridge less than 10 feet long (road length) should be represented by two V's at right angles to the road, with the points of the V's opposite each other. Dimensions need not then be given as in a larger bridge, but the material and the condition, if poor, should be noted, "brick, poor," or "wood, bad."

Roads are conventional signs. Try and show them about one-sixteenth of an inch wide at 3 inches to the mile and about one-tenth inch wide at scale of 6 inches to the mile. The road lines should stand out clear and distinct, with no lines or other

conventional signs crossing the road. Fence and telegraph signs are placed on the road lines.

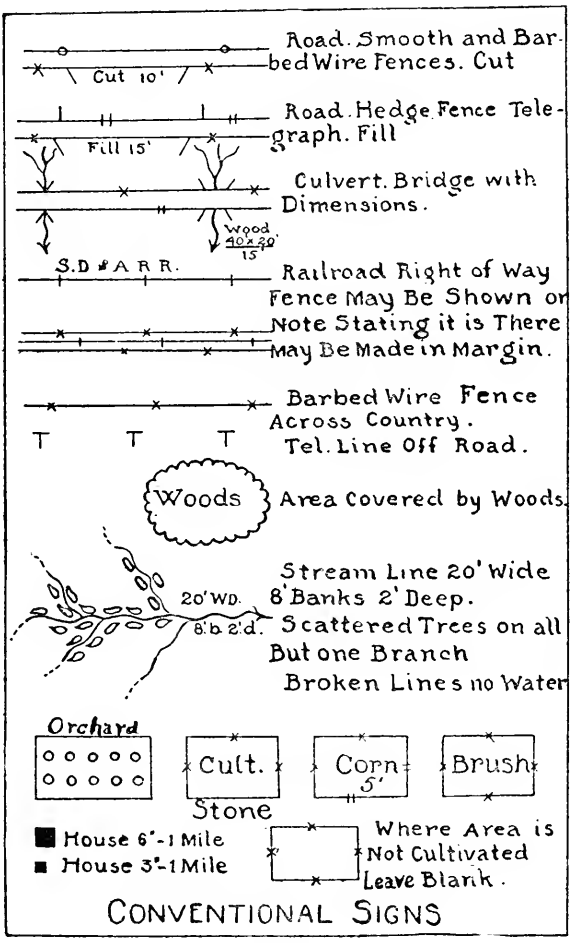


Fig. 5

A hedge fence is represented by drawing H's across one of the road lines at about the same intervals as fence signs. Fence and

hedge signs are the only marks that should ever appear between the borders of a road.

Stone and wood fences, being very unusual features, are noted in sketching by writing in "stone" or "wood" along a line drawn to represent the fence; if along a road use the road line, with marks indicating the limits of the stone or wood fence. A marginal note is simplest and easiest.

Signs for single trees are drawn oblong in shape and about one-tenth of an inch long at 6 and about one-sixteenth inch long at 3 inches to the mile. Space them sufficiently to be distinct so as to blue print readily. Do not attempt to show individual trees. The sign indicates trees in that locality.

Houses are represented by black blocks which are made square and large enough to be set in the road at the scale being used. That will make the house sign about one-tenth inch square at 6 and one-sixteenth inch square at 3 inches to the mile.

In order to proportion the signs to the scale used it is convenient to always make the lines that go on or along the road about as long as the road is wide. This refers to such signs as a telegraph line along the road, the barbed-wire fence lines which make the X's on a road line, and the signs for cuts, fills, bridges, culverts, etc.

A row of houses occupying a certain distance along a road need not be indicated individually, but house signs covering the scale distance occupied by them should be drawn in.

A dry watercourse should be indicated by a broken line, which should be wavy so as not to be mistaken for a trail sign, which is a broken straight line. If there is a small town along your road, do not attempt in a road sketch to show the individual streets, alleys, and houses, but make a town sign covering the area of the town, and write in its name. (See fig. 1, town of Dover.)

Where the conventional sign or written words can not be put in at the place desired without excessive crowding, write a (1) at that place and insert description in a marginal note opposite a (1) on the margin. Carry these marginal notes by serial numbers; on a road sketch, start them at the bottom of the margin and run up; on other sketches, start at the top of the paper and number them down.

Break contour lines on each side of a road, a conventional sign, or an abbreviation (as a description of a bridge). Never run them through.

It should be remembered that your sketch, when finished, must be ready for blue printing copies without tracing; therefore all signs should be distinct enough for this purpose. All lines should be firm and clear cut.

Anyone who has the ability to learn to read and write should be able to learn to sketch. In sketching, as in writing, however, the signs used have to be learned, and facility in making them has to be gained before much can be accomplished. Much time is wasted in the field by beginners on account of the fact that they have not sufficient familiarity with the conventional signs and abbreviations to enable them to put down the right one quickly. No one should attempt to sketch until the conventional signs are learned and some facility in making them has been acquired. This can be practiced anywhere indoors by drawing a skeleton sketch of roads and stream lines and filling in imaginary countrysides. Locate and draw in farmhouses, orchards, fences, trees, woods, cuts, fills, bridges, unimproved roads, railroads, etc. Form a general idea of scale distances, but make this practice mainly to help you to learn the conventional signs so that when you see something that you wish to represent, you will be able to put it down without having to stop and think how you should represent it. It is splendid practice for a class to have the instructor dictate to them a description of a countryside which the students represent by conventional signs at the scale ordered. The various features and objects are represented according to the distance and direction as given by the instructor. To stimulate interest and note progress the papers may be turned in and corrected. It is not only necessary to know the sign when you see it, but it is necessary in sketching that you be able to make it quickly and easily. It should be easier for the sketcher to make the conventional sign than to write the words. Practice of this kind will also assist in overcoming the diffidence that many feel about the mechanical work of drawing, as it will accustom the hand and eye to working with pencil and ruler.

A familiarity with the scale distance of some commonly used unit of measure is essential to the sketcher for putting down distances as he estimates them. All estimates of distance should be made in hundreds of yards; therefore the sketcher should be able to accurately lay off a 100-yard measure to the scale of the map. As all work in learning to sketch will be at 6 and 3 inch scales, the beginner should practice, along with

the making of conventional signs, jotting down hundreds of yards at 6 and 3 inches to the mile and inches and halves and tenths of inches. This can be done by dotting off these distances any time or anywhere and then checking them with those found on the triangular ruler. This also gives an idea of what may be shown at the different scales. At scale of 1 inch to the mile a heavy pencil line is about 50 yards wide; one-tenth inch at 6 inches to the mile is about 30 yards; at 3 inches to the mile it is 60 yards; and at 12 inches about 15 yards. This practice is most important for the beginner.

TITLE.

Every completed sketch should contain a title, setting forth the character of the sketch, the sketcher's name and rank, the locality sketched, the date, the scale (in inches to the mile), a graphic reading scale of yards, and the north and south line parallel to one side.

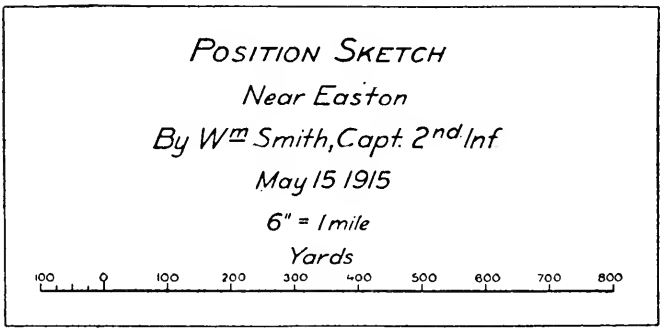


Fig. 6

All lettering on position sketches should be written so as to be read from the south edge. In place sketches it should be so located as to be read from the sketcher's position with the sketch oriented. In outpost sketches the lettering is read facing toward the enemy. In road sketches the lettering should be made so that it may be read by anyone following the route of the sketcher with the sketch oriented.

Figure 6 illustrates the title for a position sketch. In another kind of a sketch the proper name and scale is substituted.

Printed letters are so much clearer than ordinary longhand writing that they should always be used in the body of the sketch and, where time permits, in marginal notes. In reconnaissance sketches there will be so many marginal notes that it is usually impracticable to print them and they are therefore written out in longhand.

Contour numbers should also be placed, as far as possible, the same as the lettering. See figures 10 and 11.

Time is saved and the chances of omissions avoided by blocking out on heavy cardboard a completed title like the one in figure 6, and keeping it in the back part of the carrier. This can be slipped under the paper on the board and traced.

In a road sketch put the title at any convenient place. In all other sketches place it so as to be read from the south edge.

Where the V. I. used is different from that prescribed in the normal system of scales (p. 34), it should be noted in the title.

SCALES.

It is usual in military work to speak of the scale of a map or sketch by stating the number of inches on it, which represent 1 mile on the ground. Thus we say a certain sketch is made on a scale of 3 inches to the mile, meaning that 3 inches on the sketch represents 1 mile on the ground.

A scale may be expressed in three ways, any one of which is sufficient to acquaint the reader with it. These three ways are:

1. By expression in words and figures: 3 inches equal 1 mile, 6 inches equal 1 mile.

2. By what is known as the "representative fraction." This is abbreviated as "R. F." The fraction expresses map distance in its enumerator and corresponding ground distance in its denominator. For example, the R. F. of a map on a scale of 3 inches to the mile would be written R. F. $=\frac{1}{21120}$. The numerator is always reduced to unity. One (unit of measure) on the map represents 21,120 (of the same units of measure) on the ground. The scale in inches to the mile is readily found by dividing the denominator, 21,120, into the number of inches in a mile, 63,360. This scale is seldom used in sketching. Its use is mainly in case of making a sketch which may be converted into some foreign unit of measure.

3. By a graphic scale. This is a line drawn on the map or sketch and divided into equal parts. Each of these is marked with the number of ground units it represents. In our service it is usual to make these divisions read miles and halves and quarters of miles when expressing the scale graphically. This scale is useful on maps which are to be increased or reduced by photography, on account of the fact that it will always read true.

There are two other kinds of graphic scales—reading and working. The reading scale is made to read some well-known and commonly used unit of measure, as feet, yards, etc. In military sketches it is made to read yards. To construct a reading scale at a scale of 6 inches to 1 mile, lay off a couple of inches of length and divide each inch into three parts. Each part will then represent 100 yards. At that scale 0.346 inch represents 100 yards, and that is as near one-third of an inch as it can be drawn with an ordinary pencil. After dividing the inches into thirds divide the left division into four parts, each of which will represent 25 yards. Mark off the main scale to read hundreds of yards. For sketching purposes 1 mile may be said to contain 1,800 yards. At scale of 6 inches to 1 mile 1 inch will equal 300 yards and one-third inch will equal 100 yards.

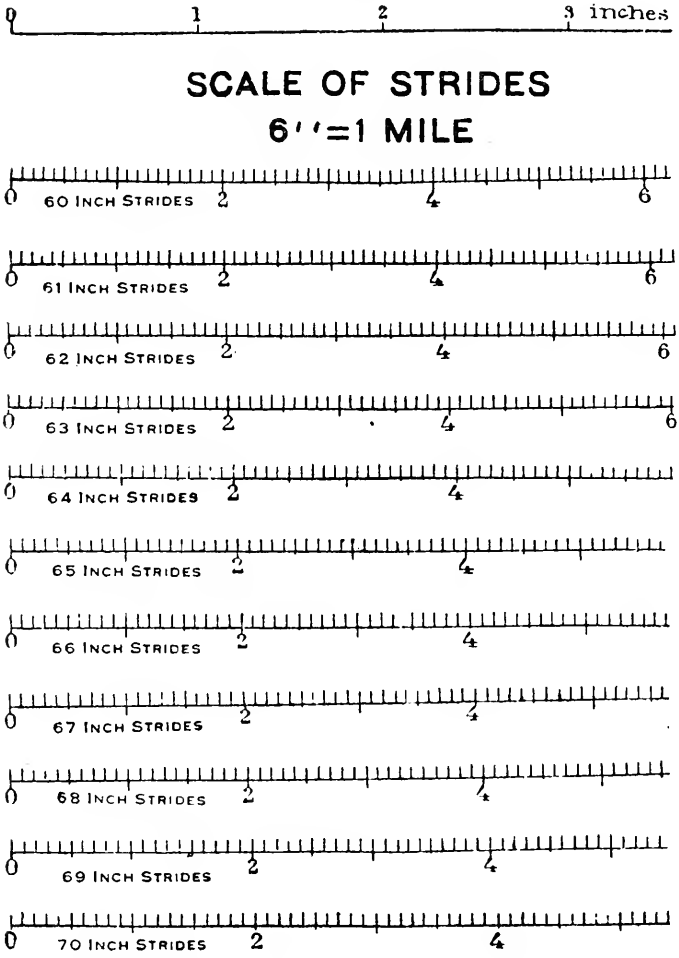
The working scale is made to read the units of measure used in making the sketch. In sketching this is usually strides (double pace) for dismounted work, and minutes of travel of horse at trot and walk for mounted work. The completed military sketch should contain the scale expressed in words and figures, as 6 inches=1 mile, and a reading scale to read hundreds of yards. The working scale should not appear on the sketch.

It is not essential that the sketcher should have to do the mechanical drawing in connection with the construction of his working scale. He should know how to do it in case of need. Scales for any length of stride or minute scales for a horse at trot and walk at any desired scale can be secured from the Book Department, Army Service Schools, at Fort Leavenworth.

Stride scales for 6 inches to 1 mile are printed in figure 7. They are placed here for convenience. To use one of them the sketcher must first carefully determine the length of his stride and either cut out the scale for his length of stride or lay off the divisions on another paper and paste on his ruler. Assume that the average number of strides taken by the sketcher over a 1-mile measured course is 1,048. To determine the length of

stride divide 63,360 (the number of inches in 1 mile) by 1,048, and the quotient, 60.4, will be the number of inches in one

Fig. 7



stride. Select the scale reading nearest to the length found. In this case 60 inches would be taken as the stride.

Scales constructed by the student should be made in ink and, when dry, pasted on to the ruler and later given a coat of shellac to make them waterproof.

It is very important that the sketcher develop a uniform stride and that the strides be accurately counted. To accomplish this is the most difficult part of scale making. The average number of strides over a given distance must be fairly uniform, or the working scale, no matter how accurately constructed, will not be of much use.

Every sketcher must have a working scale, constructed to read strides, at 6 inches to the mile. Later, one at 3 inches to the mile for practice in road sketching should be made, and when mounted work is taken up, a scale reading minutes and fractions of minutes of travel of the horse at trot and walk at 3 inches to the mile will be needed.

The making of a scale for working purposes is simple and easy enough if it be kept clearly in mind that it is merely a determination of the length that will be required to show a given number (usually 100) of strides on the ground at the scale desired.

To make a working scale of strides at 6 inches to the mile, measure off with chain or tape a ground course along a road or preferably across country "over hill and dale" of 1 mile, three-quarters of a mile, or one-half of a mile. The longer the course the better. It should be over average ground (up and down hill) similar to that which is to be sketched and should be carefully measured.

Walk this course both ways several times, counting strides with the tally register as described under "Tally Register," or by counting and tallying every 100 strides with paper and pencil. Do this on different days and at different times of day.

When it is found that the number of strides required to traverse the distance is fairly uniform, take the average of the last half dozen trials to determine your average for that distance.

In any method of constructing a scale the above steps must be taken. The further proceedings in the actual laying off and marking off the scale may be accomplished in several ways. Two ways considered the simplest and easiest are given here.

The first method is to lay off on your paper the scale distance in inches of the course and divide it into as many parts and fractional parts as you have hundreds and fractions of hundreds of strides in your average.

Each full division will then show the length on the working scale that will represent 100 of your strides at the desired scale. The fractional division will represent an odd number of strides and may be erased, as there is no need for it.

As an example, assume that you find the average number of strides to cover a measured 1-mile course is 1,048. Lay off a line 6 inches in length (the scale distance for 1 mile) and divide it into 10.48 equal parts.

Each full division will show the distance on your working scale which is required to represent 100 of your strides at a scale of 6 inches to the mile.

To complete your scale, divide the left one of the 100 stride divisions into 10 equal parts. This part of the scale is called the extension and is made in this way for convenience. Each of the 10 parts in the extension represents 10 of your strides. Mark the dividing line between the extension and the main scale as zero and then each dividing line along the main scale between the other parts with the number of hundreds of strides it measures from the zero mark.

It should be remembered that when this method is used the line to be divided in making a scale corresponding to 6 inches to the mile must be the same proportional part of 6 inches that the course on which the average number of strides was secured is of 1 mile. That is, if the course is 1 mile, lay off 6 inches; if it is three-fourths of a mile, lay off (three-fourths of 6 inches) $4\frac{1}{2}$ inches; and if the course is one-half mile, lay off (one-half of 6 inches) 3 inches.

The second method is to ascertain the length in inches or fractions of an inch which will represent 100 of your strides. Having this, lay off the number of divisions of that length desired, mark them and paste them on the ruler. For example: Assume that the average number of strides to 1 mile is 1,048. It is desired to construct a working scale at 6 inches to 1 mile. Divide 6 by 10.48 and the result (0.572 inch) will be the length on your working scale which will represent 100 of your strides at 6 inches to 1 mile.

With a scale of equal parts (one reading inches and tenths of inches will serve), lay off as many divisions 0.572 inch long as you may desire in your scale, and each of them will represent 100 of your strides at 6 inches to the mile. Mark off the extension and the main scale as previously described, trim to suit, and paste on ruler.

When a scale of strides for 6 inches to the mile has been made, all that is necessary to construct one at 3 inches to the mile is to take off on a piece of paper the divisions on the 6-inch scale and mark them with just twice the value they have at the 6-inch scale. Each division of the extension will represent 20 strides at 3 inches to the mile.

Either of the foregoing methods may be used in constructing a time scale for a horse. It is first necessary that the horse should be trotted and walked several times over a course and his average time of travel secured. In doing this care should be exercised that the horse's gait is not influenced by the presence of another horse, the fact that the animal is tired or fresh, that he is going toward or away from the stable, etc. Allowances must be made for such things, and practice enough should be had, before constructing the scale, to enable the sketcher to determine pretty well whether or not the horse is taking a uniform gait.

Working scales should be tested from time to time by the sketcher in order to be sure that his stride is not changing. This can be done by occasionally checking traverses with a Geological Survey map or by measuring with chain and tape some of the distances traversed.

WHAT A SKETCH SHOULD SHOW.

Broadly speaking, a military sketch should show all natural and artificial features of the surface of the earth in the area sketched. The magnetic-meridian line, a title giving the character of the sketch, the locality sketched, the date, the sketcher's name, the scale of the sketch, and a graphic scale reading hundreds of yards should also be shown.

Natural features (bodies of water, woods, etc.) and all "works of man" are represented by conventional signs, drawings to scale, or by written words.

The configuration of the ground is represented by contours showing elevations and depressions with the character of their slopes and relative heights as truly as the scale of the sketch, the time allowed, and the sketcher's ability will permit.

All detail, except that shown by contours, is called flat or horizontal detail. That shown by contours is called vertical detail. The military sketch must have every feature located in its relative horizontal and vertical position.

HORIZONTAL DETAIL.

The horizontal position of any point is determined when its direction and distance from a previously determined point are shown. The vertical position is determined when its elevation with reference to an assumed level, called a datum plane, is shown.

The line from which all directions are measurd is the plane of the magnetic compass needle, called the magnetic meridian. The true north and south line (true meridian) need not be considered in sketching. It is most important when direction lines from one point to another are located that the sketching board be oriented (explained under "Sketching Board"). The sketcher should therefore always verify the position of the needle or of the arrow on his board before drawing a ray (light line) toward the object whose direction is being determined.

The position of a point, with reference to direction and distance, is determined in one of the following ways: (1) Traversing; (2) intersection; (3) resection; (4) estimation.

TRAVERSING.

By this is meant the measurement of the distance between two points by counting the strides or time of travel required to pass from one to the other.

The term traverse is applied to the route followed by the sketcher in making the sketch.

To locate a point by traversing.—Being at point A (whose position is plotted on your sketch) with the board oriented, stick a pin in point A, on the sketch. Lay ruler alongside the pin and pivot it around until point B (the point to which you are to traverse) is sighted. Verify the position of the arrow and then draw a ray toward B. Move to B, counting strides, and upon arrival lay your ruler along the ray with the zero of scale of strides at A and lay off on the ray the number of strides that you took between the two points. The point marked is B.

INTERSECTION.

The position of a point is determined in this method by drawing rays toward it from each of two other points, whose positions are already determined and plotted on the sketch. The intersection of the two rays is the sketch position of the point sighted.

To locate the position of a point by intersection.—Assume that from point A, with your board oriented, you took a careful sight and drew a ray toward a church a few hundred yards off to the side. After arriving at B and plotting its position, you carefully orient the board by a back sight on A. Pivot the ruler around the pin in B until the church is sighted, then draw a ray toward the church. The intersection of this ray with the one you drew from A is the sketch position of the church.

RESECTION.

This is determining the sketcher's position by orienting the board and drawing rays toward himself from two or more points whose positions are already determined and plotted.

To locate position by resection.—After having plotted the position of points A and B, the sketcher comes into his area later at some point from which those two points can be seen. His present position is not yet determined. To determine it, set up the board and orient as carefully as possible by the arrow, then stick pins in the sketch positions of points A and B. Pivot the ruler around the pin at A on the sketch until you sight A on the ground and after verifying the position of the arrow, draw a ray toward yourself. Next pivot the ruler around the pin at B on the sketch until you sight B on the ground, and after glancing at arrow, draw a ray from that point toward yourself. The intersection of the two rays is the sketcher's position.

There are other methods of resection, but their use is so exceptional that they need not be considered.

ESTIMATION.

After some practice, points nearby are located very accurately by simply estimating their distance and plotting their position on a ray drawn toward them. Advantage is taken of any feature in the locality that may assist in determining the distance, such as telegraph or telephone poles, fence posts, section lines, etc. The ability to estimate distances should be cultivated at every opportunity. A good sketcher must be able to estimate with less than 10 per cent error up to about 300 yards and within 20 per cent up to a mile. This ability can only be acquired by constant practice and by verifying the estimates by measurements. All estimates should be made in yards, and 100 yards should be definitely fixed in mind as a reference unit.

Do not estimate on main traverse.

VERTICAL DETAIL.

The United States Geological Survey uses sea level as datum plane in determining elevations of points.

In military sketches the area is comparatively so small that the datum plane used is immaterial. The reason for this is that what is desired is the elevation of the different points in the area with relation only to the other points in it. It is immaterial whether the elevation of the starting point is assumed to be 500 feet or 1,000 feet, but all other points must then show their elevation with reference to the assumed one.

It is well to ascertain the Geological Survey elevation of some point and start from there, because the sketch can be checked against a Geological Survey map more conveniently when the elevations are the same, but it is not at all necessary that this be done.

Under our normal system of scales the vertical interval (V. I.) used on military maps and sketches can be found by dividing the number of inches representing 1 mile in the scale into 60. For example, at 6 inches to 1 mile the V. I. is 10 feet. At 3 inches it is 20 feet, and at 12 inches to 1 mile the V. I. is 5 feet.

The vertical position of a point is located by determining its elevation above or below some other point whose elevation has already been determined.

The determining of difference of elevation of two points by estimation is the method of the experienced and rapid sketcher. After some time and with considerable practice the sketcher acquires ability to estimate differences with great accuracy.

There are many ways in which practice in estimating elevations may be had. The ability to strike one's own level is of great value. This can be practiced indoors by swinging the extended arm around with the hand at level of the eye, so that the line of sight over the back of the hand passes through marks made upon the wall at the exact height of the eye.

Having learned to strike your own level, practice estimating distances or objects above and below this plane by comparison with the heights of ordinary objects in the vicinity, such as telegraph poles, trees, etc. Fix in mind a 10-foot unit and apply this to the height being determined.

In connection with estimating either horizontal or vertical distances it is well for the beginner to remember that it is

fatal to good estimation to depend upon his judgment until he has a definite and clear idea of what the units of measure he is using really are, and hence he should if possible check all estimates until he has attained the ability to estimate with a minimum of error. This will come only with practice and constant checking.

CONTOURS.

The representation of vertical distances by means of contours seems hard to the beginner. This is largely due to the fact that the average beginner usually attempts to contour before he really knows what a contour is, what laws govern their making, or what may be shown by them at the scale being used. Before attempting to do any contouring in the field the beginner should gain a clear idea of these things by careful study and much practice, so that when he takes up contouring he will know what he is trying to do.

Contours are lines drawn on a map or sketch, which, following the various levels at fixed vertical intervals, indicate the shape of the ground and show its vertical irregularities.

The general laws governing the use of contours may be fully learned only by actual field work. Some are noted here:

1. Every contour line either closes on itself or both ends of it go off the sketch.

2. Every part of a contour line is at the same level.

3. A contour about to cross a stream line runs up on one side of the stream and comes down on the other, making a V where it crosses. The apex of the V points upstream.

4. Contours representing spurs between stream lines are generally U-shaped, with the bottom or rounded part of the U pointing down hill.

5. Valley contours apparently go in pairs; that is, the contour next to the stream line on one side is the same contour as the one next to the stream line on the opposite side. If you cross the 800-foot level just before you wade into a stream, you must cross that same level again when you wade out on the opposite side.

6. Ridge contours also apparently go in pairs. The contour next to the top of a ridge has its mate next to it just over the ridge.

7. In the case of the contours on opposite sides of the stream their meeting point will generally be found close by; in those

next to the ridge top it may be that they do not join up on the sketch, but if the area were extended their meeting point would be found sooner or later.

In sketching do not attempt to show a cliff by contours. Break the contour lines on each side and write "Cliff 60'" (or whatever its height may be). Do the same with a bluff which is so high and steep as to make difficult clear representation by means of contours. If you have a depression to represent, be sure that the contours showing it are clearly numbered, so that it may at once be understood.

DETAIL SHOWN BY CONTOURS.

The amount of detail that may be shown by contours depends directly upon the scale of the sketch. Failure to realize this is one of the reasons why the representation of ground forms by contours is often difficult for the beginner. For example, on a scale of 3 inches to the mile a spur 100 feet long jutting out from a hillside would cause a contour line to change about one-twentieth inch, the scale width of the spur. If trouble were taken to change an otherwise regular contour to indicate this no one would notice it nor care anything about it if it were noticed. It is true that this spur might furnish cover to a number of the enemy, but when the commander wants a sketch in which such cover becomes important, he will have it made on a larger scale.

The minimum size of ground features that can be shown to advantage to the scale used should be determined and kept clearly in mind by the sketcher. Then, so far as anything smaller is concerned, he should regard the ground as smooth and regular. This will greatly simplify his work.

It must be realized that any details that can not be shown clearly and naturally to the scale ordered are not wanted. This, of course, refers only to those features that are to be shown to scale. Houses, bridges, roads, stream lines, etc., being represented by conventional signs are not drawn to scale.

A good method to follow to gain an idea of what can be shown at the various scales by contours is to take a map or sketch of an area and carefully study the ground represented and note the smaller details that are not shown on the map. Compare map and ground, again noting carefully the ground forms as they are on the ground and then how they are represented on the map.

A box filled with sand, called a sand table, is a great aid in studying ground forms and may be used if time permits and outdoor work can not be done. Many exercises can be held in which much can be accomplished in learning how to contour. Make a mound, assume a scale, and represent it by contours. After drawing in the flat detail of a sand-table terrain, contour the area, first determining the elevation of the critical points, then spacing the contour points by eye, according to the slopes, and then connecting up the levels.

Take a section of a contoured map and reproduce it on the sand table according to scale. Later, without looking at the contoured map, make a sketch of the area and compare it with the contoured map.

Any ground forms can be produced and their contour lines studied out and drawn. The amount of work that can be done on the sand table depends upon the time the student will give to it and his ingenuity.

The value of the sand table is, of course, limited to giving a thorough understanding of ground forms and of their representation by contour lines. This understanding is essential to the sketcher. Practical familiarity with ground forms and ability to represent them correctly can only be gained on the ground, for the only way in which the ground perspective can be appreciated is by study of the ground itself. To the beginner, ground distances appear greater and features near by larger than they actually are, and this can only be corrected by actual work on the ground.

LOGICAL CONTOURING.

The Engineer Department at the Army Service Schools at Fort Leavenworth has had printed a number of plates for the purpose of practice in drawing contours. These show the flat details of the area and the elevations of critical points. The entire series should be filled in by every beginner and corrected by an instructor before attempting any fieldwork other than filling in flat details. The series consists of several sheets, each with four areas. These can be secured at small cost from the Book Department, Army Service Schools. Too much of this practice can not be had. The method of filling in the contours is illustrated in figures 8, 9, 10, and 11.

Practice in logical contouring, as it is called, is most necessary to a clear understanding of contouring in sketching. The

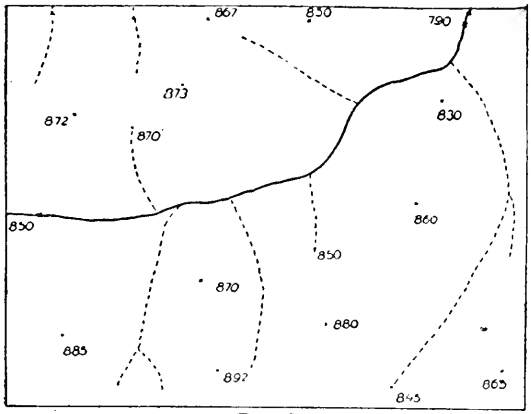


Fig 8

Arrow heads on Fig. 8 show direction of water flow. Place 10′ contours on the above sketch.

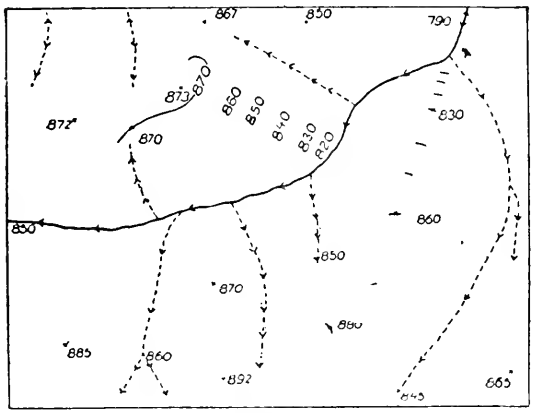


Fig 9

Arrow points on Fig. 9 (except those also appearing on Fig. 8) are points where contours cross streams or dry runs.

more of it a student does the better. Anyone can make up a framework, similar to those shown in figures 8, 12, and 13, and practice contouring by logical methods.

The procedure, as shown, is to first note the elevations of critical points along stream lines and ridges, then divide up and mark crossing points of contour lines along the main stream

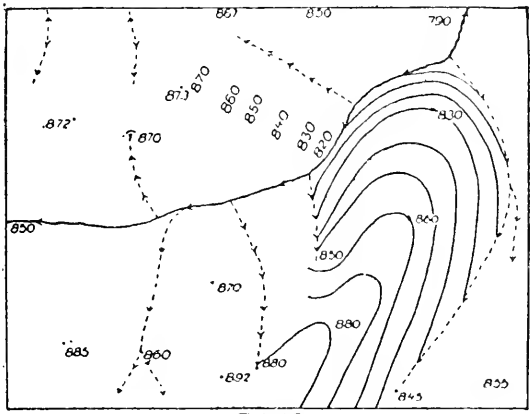


Fig. 10

line, then along the tributary streams, marking those on stream lines with a V pointing upstream, then from points along the

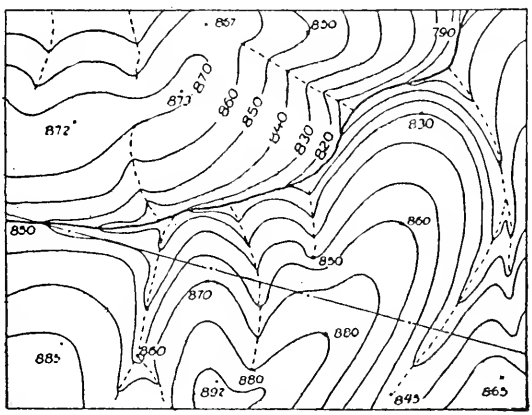


Fig. 11

stream lines to ridge-line points near by, mark (with dots or short lines) the crossing points of the number of contour lines that go between, according to the elevations of the top and bot-

tom points. Finally, having enough of these to shape the ground, join them up by long curving lines.

On all sketches, the contour lines should be numbered so that the elevation of any one of them can be readily found. They should be numbered where they leave the area and occasionally along a stream line or on some of the longer slopes (fig. 11). The completed sketch should have each 50 or 100 foot contour line drawn heavier than the others.

CONTOUR FRAMEWORK.

Critical points are those at which an abrupt change in direction or slope takes place, such as bends in roads or streams, stream junctions, tops of ridges, hills, etc. Any feature which may assist the sketcher in securing his framework, may be called a critical point.

Manifestly, it is impracticable to determine the exact location of the crossing points of each contour line between all the critical points. It is equally impracticable to determine the location of every slight change of slope on a hillside. Such detail is not important and is not wanted. Hence, the sketcher ascertains the elevation of critical points, thus locating the position of the form-controlling contours and interpolates the contour lines between them, spacing by eye to indicate the change of slope as these changes appear to him.

The undulations and vertical distances in the form of the ground are largely caused by the erosive action of rainfall, hence the drainage system and ridge lines form the framework on which contours are hung.

If the sketcher determines: (1) The elevation of the main stream line at the point where it enters his area; (2) the elevation of its junction with its tributaries, in the area; (3) the elevation of the main stream where it leaves the area, he will have a good base from which to build up his contours. If, while determining the above, he also determines the elevations of the tops of the ridge lines between the stream branches and of important points along and on these ridges, he will have the highest as well as the lowest levels in the area and need only fill in the contours between the points whose elevations are known.

The foregoing is exactly what the sketcher must do in contouring. As he goes over his area, drawing to scale the flat or horizontal details, he locates all critical points and estimates and notes their elevation. Then, having enough of the drainage

system and ridge lines "pinned down" to enable him to show the big features, he dots in the level lines at their proper vertical intervals between critical points according to the slope of the ground. Finally he connects up the dotted points by contour lines, each running through the dots of its own elevation.

In reality, contour lines in sketching are nothing more than conventional signs. A sketcher will soon find that every slope is one of three kinds—uniform, concave, or convex. When spacing in contours, this should be kept in mind. Any slope of

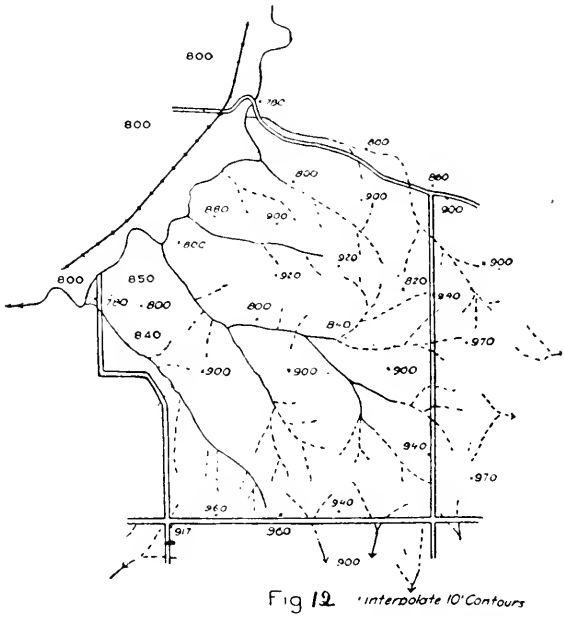


Fig 12 Interpolate 10' Contours

ground may be divided into sections, each of which may be represented by one of the three kinds mentioned. Practice alone will enable one to pick out the dividing lines, but they should be looked for from the beginning.

Where the slope is uniform, space your contours equal distances apart; where the slope is concave in form, space your contour lines closer together near the higher elevation and wider apart toward the lower; where the slope is convex, space them wider at the higher and closer at the lower elevation.

The beginner must learn to consider general knowledge of country, of rates of fall of streams, of railroad grades, and of ground forms in order to keep his work logical and consistent. For instance, large rivers have a fall of only a few inches to the mile, unless there are many rapids; therefore, within the limits of an ordinary reconnaissance sketch, a large river is at the same level, for purposes of determining elevations. A stream

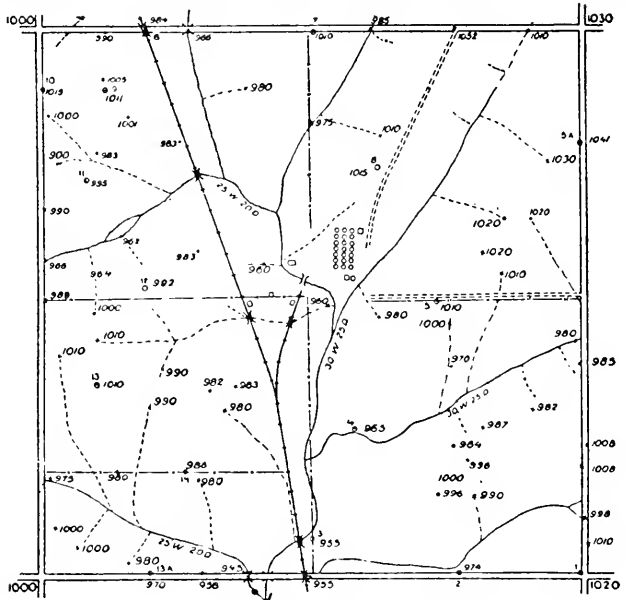


Fig 13

line carrying water all the year round has a less fall per mile than one in the same area which is dry part of the time. Tributary streams have a greater fall than main stream lines. The nearer the stream to the source, the steeper it falls.

NOTES FOR FIELD WORK.

Avoid complicated and cumbersome methods.

Always use the simplest and most common-sense way.

Do everything possible, consistent with requirements of making the sketch, to save time. When you halt to make a note,

make it, and go on. When you halt to fill in something and it is not necessary to orient, do not orient but do the filling in quickly, and move on.

Never orient the board unless there is necessity for it.

Every time you orient the board by arrow or compass, verify it by a back sight, if practicable. Every time you orient by a back sight, verify it by the arrow or compass.

Always verify the orientation just before you draw a ray either along a traverse or in intersection or resection.

Try to acquire the habit of doing the necessary things at each halt in the same sequence. For example, traversing along a road, you arrive at the top of a rise, to which you had drawn a ray. Halt there, look around, and select the best position for sighting forward on the traverse. Lay the board down on the ground or place it on your knees. Take out ruler and pencil, and placing ruler alongside the ray, with edge of working scale next to it, measure off the number of strides from last station and mark with pencil dot. Stick a pin in this dot which is your present station. Lay ruler along ray to last station and orient board by back sight. Having the board oriented, pivot the ruler around the pin and draw a ray to the next station. Now sight and draw rays to such points as you may have drawn rays to from previous station, to complete their location by intersection and then draw rays to such new points as in your judgment may be of use, noting in each case the object sighted. Verify orientation each time before drawing ray. Now draw in the other road line (the ray taken to this station is one) and fill in the flat details, houses, bridges, stream lines, fence signs, etc., from the last station to your present one. Determine the elevation of your present station by estimating the difference between it and the previous one. In the same manner determine the elevation of any critical points that you may have noted in your traverse from last station as well as of points located by intersection. If you have enough data to enable you to contour between stations, do it now; if not, be sure that the elevations of critical points are noted. Put the ruler, pencil, eraser, pin, etc., in their proper places, pick up the board, and start traverse to next station.

The operations noted in the foregoing have to be carried out at each station. Failure to carry them out in sequence while learning to sketch will handicap the beginner very much. It

is therefore considered essential that the beginner should learn to do them in the sequence described. After a while he will develop the simplest and best way for himself.

Have your sketch completed up to your station before moving on. In the earlier stages this applies only to flat details, later to both horizontal and vertical detail in road sketching and to horizontal detail and the location and determination of the elevation of critical points in making a position sketch. The contouring in this case is not undertaken until the entire framework of ridge and stream lines is "pinned down."

Be particular that the information conveyed is not misleading. It is better to leave a part blank than to deceive or mislead.

Try to put equal care and time on all parts of the sketch. Avoid excessive care at the beginning followed by excessive haste near the end.

Acquire method and system in your sketching and the rest will be easy.

POSITION SKETCH.

It is assumed that before undertaking to make a position sketch the sketcher has followed out the course of study outlined herein.

Select an area of ground about one-half a mile square. One having roads on all sides is better, but this is not material.

Determine where to locate your starting point on the paper by estimating the direction from you in which the area to be sketched lies. If you are at the southwest corner of the area, locate your starting point (by sticking in a pin) about 5 inches from the west edge and 5 inches from the south edge of the paper. Since the area to be sketched will occupy about 3 inches square when drawn to scale, you will thus have it at about the center of the sheet.

Draw the magnetic meridian line parallel to the edge of the paper, then orient board. Take forward sight to next station and draw ray toward it. Assume elevation of starting point and note it. Now traverse all the way around the area, locating as you go the position and elevation of all critical points along the traverse. Fill in all horizontal detail along and near the traverse, inside the area, within easy estimating distance (a couple of hundred yards) by estimation and farther off by intersection methods.

In traversing around the area, in addition to cuts, fills, orchards, etc., locate the following:

1. Every stream or drainage line crossing the traverse or running close to it. Note the direction of its flow and its fall. If this is not at once apparent, take time to find out. This is important.

2. Every house or other feature easily identified near the traverse, which may later be useful in finding yourself. Sometimes some feature outside of the area may be extremely valuable. For example, a tall chimney some hundreds of yards from the area may be visible from all points in it; to locate this by intersection early in the work may save much time later.

3. The high points between drainage lines along the traverse (determine and note their elevations). Proceeding simultaneously with the traversing, dot in (according to the slope of the ground) and mark the crossing points of the contours between critical points along the traverse whose elevations have been determined. Do not draw any contours yet; wait until later, when you have the stream line and ridge framework completed and can see the area as a whole. The big features will then be distinct, and the little ones will take care of themselves.

ADJUSTMENT TO CLOSE.

When you reach a point from which the starting point can be seen, you will probably find that the ray to that point does not pass directly through it. This is to be expected. If the error is less than 10 per cent of the entire length of the traverse, it is satisfactory. If it is greater, there has probably been some error in your orientation. If you are not able to determine just where the mistake occurred, distribute the error by adjustment. To do this, move the last point to or from the point of starting, the next traverse line a little less in the same direction, and the next one a little less than the previous one. Remember the scale you are using and the scale width of a road as it is drawn on the sketch. Do not waste time in making this adjustment, but in making it, be sure that you do not make an angle between roads which is noticeably different from the actual ground angle made by the roads. Otherwise some one may be misled. Your sketch will have errors in it, but it must not contain misleading or deceptive information.

COMPLETING SKETCH.

Having traversed completely around your area and having noted the location of all drainage lines crossing its borders, you will have a pretty fair idea as to which is the main stream line and where it lies. You must now find out how the smaller stream lines connect up with it in the area in order to complete your framework. It is now time to traverse into the interior. Select a road or trail if one is nearby; if not, select some point in the interior and draw a ray to it, being careful with the orientation when you draw it. Traverse along the road or ray and keep going until it seems advisable to stop. Then plot your position, fill in flat detail up to your location, determine your elevation, and then, after orienting the board, draw rays to such stream junctions and high points as seem to be valuable. In this manner traverse across the entire area, locating stream lines, stream junctions, ridges, and hilltops, fill in flat detail, determine elevations as you go and note those of critical points along and near your traverse. It may be necessary to traverse across the area in the other direction before all critical points are determined, but on such a small area it will probably not be. After having located the drainage framework and ridge lines and determined their elevations you are ready to contour. This should be done by noting the slopes as uniform, concave or convex, and spacing the contour lines accordingly. After a little practice, it should be possible to contour any area that the sketcher has been over, from one or two places from which he is able to see the slopes. Until the sketcher becomes pretty familiar with ground forms and their representation by contours, he should take time to dot in the crossing points of the contour lines between all adjacent critical points. This will take a little longer but will save much time later because of the practice it gives the hand and eye.

Put on the title as described on page 26, and the sketch is finished.

OUTPOST SKETCH.

In the execution of an outpost sketch, which is made on a scale of 6 inches to the mile, V. I., 10 feet, the methods followed are the same as those of a position sketch, except that the sketcher is confined to one side of the area.

Points along the outpost line are located by traversing, while those to the front are determined by intersection or, in some

cases, by estimation, as for instance, where a feature can be seen from one place on the line only.

Having made two or three position sketches, the beginner should be able to start at one end of the line and carry his operations along to the other end and then from some advantageous position contour the area.

A little study of the area before starting the sketch will be of value in determining the best method to follow.

Traverse the outpost line, sketching it as you go, and drawing rays from different stations to points in the foreground, thus locating them by intersection.

The angle between the intersection lines should be as near 90° as possible. Therefore, the points on a straight line from which the intersecting lines are drawn should be far enough apart, if the ground will permit, to secure this. It is thus evident that the farther out the points are, the farther apart should be the points from which the intersecting lines are drawn. Conversely, the nearer the object, the shorter need be the distance between the points on the traverse line from which the rays are drawn.

The distance to be sketched to the front depends upon the time available and the character of the country. In all practice work the sketcher should include the area as far to the front as he can see.

It is frequently the case in outpost sketching that it is possible to locate and draw in one end and the direction line of a straight road, fence line, railroad track, or telegraph line. If this can be done, all points along it are accurately located by drawing a ray to them from determined points along the traverse, thereby completing the intersection.

In contouring the outpost sketch, the same methods are followed as in the position sketch. The stream line and ridge framework have been secured by the sketcher in his traverse, and it only remains to interpolate the contours according to the slopes of the ground as they appear to the sketcher.

Any part of the area that can not be seen, as the far side of a ridge parallel to the traverse, is drawn in by broken contour lines, which indicate that, in the opinion of the sketcher, the ground is shaped as shown by them, although he has not visited it.

Field glasses may be of use in outpost sketching in picking out objects on which to intersect or for discovering folds in the ground that are not visible to the naked eye.

PLACE SKETCH.

A place sketch is one in which the sketcher is limited to a single point of observation overlooking the area to be sketched. The details to be shown are the same as on a position or outpost sketch.

If made to extend a road or position sketch farther toward the enemy than can be reached by the sketcher, the place sketch will be at the scale of the sketch thus extended, otherwise at 6 inches to the mile and 10-foot V. I.

The methods of work described for making a position and outpost sketch are followed, except that the location of points is determined by estimation, assisted by intersection methods where possible.

It is advisable to select some few prominent features in the area, determine their position and elevation as carefully as possible, and then use them as reference points in locating other points. A road, a hedge fence, a wire fence, a railroad, or any such feature should be located and drawn in as soon as possible and used for basing other estimates and for locating points along it by intersection.

Parts of the area that can not be seen, but which the sketcher is able to estimate, should be represented by broken lines, as in outpost work.

Place sketching is extremely valuable to the beginner, who has progressed through position and outpost sketching, on account of the practice that it gives in estimating distances.

ROAD SKETCH.

Before taking up road sketching, the beginner should be able to make a position sketch and should have made a few outpost and place sketches, for the benefit of the practice in intersection and estimation which he gains by them. He should also learn something of what can be shown to advantage on a 3-inch scale.

It is advisable to make one or two short road sketches dismounted before taking up the road sketching proper, which is done mounted.

The methods followed in road work are a combination of those used in the other classes of sketches which have been

described. The scale is usually 3 inches to 1 mile with V. I., 20 feet. The sketcher lays the board on the ground or places it on his knees as he sits down.

The road sketch should include all the country for 400 yards to each side of the road, all artillery positions within several miles, and all commanding positions within rifle range of about 1 mile. It should show any prominent landmarks and where roads, railroads, etc., come from and go to, the names of rivers and larger streams, of the families living at crossroads or in isolated houses, of towns or villages, as well as all information that is given in position, outpost, or place sketches.

Arriving at his second station, the sketcher should draw in not only all horizontal detail from the first station, but should contour the area he has passed over before starting on his next traverse. It is for this reason that it is considered better for the beginner not to attempt to make a road sketch until he is somewhat practiced in sketching methods.

Do not waste time in orienting, but after laying board down or standing up with it leveled in front of and pressed against the body, orient by back sight and check by noting that arrow on board is to north.

With the board held pressed against the body, to draw a ray to a distant object, first orient the board, then pivot the ruler around the pin to its approximate position, and glancing down at the ruler and at the object alternately, determine when the ruler is pointing at the object. Glance at the orientation, carefully secure the ruler with finger or thumb, and then draw the ray. This will be found quite difficult to do at first, but a little practice will make it easy. Points determined by intersection of rays taken in this manner are very accurately located after some practice.

The road sketch is carried along in the manner indicated from station to station, being completed at each point before moving on to the next.

Many points within 400 yards of the road will not be visible to the sketcher from his position opposite them in the road, but they may be from some point further on. In any case, make it a rule not to leave the road. Fill in such places as you think they are, as described in outpost work, or leave them blank, as their character will be seen by the reader of the sketch.

In case the sketch should threaten to run off the paper, the procedure is to fill in the detail a little beyond your station (which is now close to the edge of the paper) and then, choosing a new point of beginning on the paper, locate your station there, draw a magnetic-meridian line near by, and duplicate the filling in previously done, around and beyond it.

Go right ahead with this part just as though the other part was a different sketch, but when the sketch is finished cut the paper between the two parts, and laying the points which you filled in twice (once near the edge of the paper and again when you started the new part), one over the other, turn the papers until the M. M. lines of the two parts are parallel, and then paste them together in that position. The sketch may run off the paper several times, but so long as the finished sketch shows the meridian lines of all different parts parallel to each other this is immaterial.

In mounted work the sketcher must, while controlling the horse and riding along the road, jot down the features as they are passed. This is done on the pad as described on page 20.

Practice in noting down features while riding at a trot should be had before going out to make a sketch. It is quite difficult for some to learn, but anyone can do it with practice.

System in methods of work is most important, as time is a big factor in mounted work. All sketching is done, as in road sketching, dismounted. The board is swung under the left arm by the cord passing over the shoulder, and the watch (if using the stop watch) and pad are held in the left hand, finger close to the stop of the watch. Using the stop watch and pad is largely for convenience. Satisfactory mounted work may be done by using an ordinary wrist watch on inner side of left wrist, from which the time of passing a feature, etc., may be noted on a pad held in left hand.

The reins are held in the right hand, over left wrist, or with a knot tied in them across the pommel of the saddle, where they can be quickly grasped.

If you have an assistant, which is desirable, have him carry the board and hold your horse when you halt. The assistant should be with you while rating the horse and ride either abreast of or behind you, as he is to do during the sketching.

Immediately after mounting take the pad in left hand. As the horse starts press the stop, being careful to see that stop watch is at zero.

Keep your eyes on the country and on your watch alternately, so that when you see a feature you will not have to hunt for the proper place on the pad to locate it. It may be necessary at first to stand in your stirrups and lean forward with arms close in while making the marks in order to get readable ones. Note the direction of flow of the stream lines as you pass them.

At first traverse about a minute at a time and then dismount and complete the sketch in the same manner as in road sketching dismounted. The time spent in traversing is small in comparison with that spent in plotting the notes taken.

Arriving at a halting place, stop the horse, press the watch stop to secure correct time or note same from watch, throw sketch-board cord over the head and lay the board on the ground, or sit down and place it on your knees. It is better to lie down on the ground on the stomach and with pad at hand and the board on the ground, measure off the minutes of travel and fill in flat detail and critical points according to the notes. Then orient the board and draw a ray to the new station or in the new direction along the traverse. Then, taking the board up as previously described, contour the sketch up to your position.

In field service the information desired in a road sketch is largely that which will enable another to follow the reconnoitered road. For this reason contouring is of less importance than direction, distance, land marks, and condition and practicability of roads. In learning how to sketch, however, it is considered necessary that the sketcher practice contouring in road sketching, not so much because he will do this in service as because the practice in rapid contouring is invaluable in the study of ground forms and their representation.

RECONNAISSANCE SKETCHES.

The tactical situation and the intentions of the commander will indicate in each case the information that is especially desired. The information secured is conveyed by means of a sketch amplified by a report in marginal notes numbered serially. All information that it is possible to show clearly is contained in the sketch. The report consists of descriptions of features and objects, measurements, material, construction, etc., which can not be conveyed in a sketch. The serial reference numbers should run in order on the margin. The numbers are

placed on the sketch near the object to which they pertain, so that it will be clear to what they refer. In making the notes clearness and brevity are desirable. Such terms as "before," "behind," "this side of," etc., should be avoided and compass directions used. The terms "left" and "right" may be used in referring to the banks of a stream, in which case the sketcher is assumed to be facing downstream.